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Effect of gamma rays and ethyl methane sulphonate (EMS) on yield and yield attributes of *Cicer arietinum* in M₁ generation

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ABSTRACT

A study was conducted to compare the effect of mutagens on yield and yield attributes of chickpea in M₁ generation. In this regard, 'CO-4' variety of chickpea was subjected to different concentrations of gamma rays (20, 30, 40, 50 and 60kR) and EMS (10, 20, 30, 40 and 50mM) for inducing mutation. The effect of gamma rays and EMS with different doses/concentrations on yield and yield attributes were observed in M₁ generation. From the result, it was observed that the mean value of all the quantitative traits of M₁ generation showed a reduction upon enhancing the doses of mutagen. Mean performance in terms of these traits showed good qualities in comparison with the treated plant. The lethal doses were found in 40kR of gamma rays and 30mM of EMS and were carefully analyzed for further generations.

KEYWORDS: Induced mutation, gamma rays, ethyl methane sulphonate (EMS), *Cicerarietinum*, M₁ generation

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INTRODUCTION

Chickpea has a very important role in human diet, especially in India. India is the largest in production and utilization of pulses in the world, accounting for nearly 35% of the world area and 22% of world production [1]. Further it has been observed that the total acreage under pulses is gradually declining for the past two decades. This brought down the per capita from 6.7g/day in 1951 to 3.7g/day in 2009 [2] against FAO's recommendations of 500 capita per day. In order to overcome the per capita production reduction, there should be varietal enhancement in indigenous production.

M₁ seedling development is generally utilized as a tool in deciding the natural impact of different physical and chemical mutagens [3]. Mutagens vary in their component and method of activity in different plants. Subsequently, the degree of decrease in development is identified with the component of activity for a given mutagen [4,5]. The parameters of M₁ age help in determining the adequacy and effectiveness of mutagens, other than distinguishing the plants with most extreme hereditary harm that are probably going to convey the high recurrence of small scale changes in later period of growth [6,7].

Mutation studies have been conducted in a variety of plants to aid in mutation breeding programs, plants like Tenai

(*Setaria italica*) [4], *Dianthus* [5], *Eleusine coracana* [6,8], *Cajanus cajan* [9] and *Abelmoschus esculentus* [10] are examples. The present study is an attempt to elaborate genetic variability for crop improvement by induced mutagenesis through physical and chemical mutagenesis in CO-4 varieties of Bengal gram (chickpea).

MATERIALS AND METHODS

Seeds of chickpea 'CO-4' variety from Tamilnadu Agricultural University, Coimbatore were used in the present study. Ethyl methane sulphonate (EMS) treatment (10,20,30,40 and 50mM) and gamma rays (20, 30, 40, 50 and 60kR) treatments were given as explained previously [11].

The M₁ generation was raised in Botanical Garden, Department of Botany, Annamalai University in a complete randomized block design (CRBD). Harvesting was done from mature individual of M₁ plants. The cultural conditions were followed as explained earlier [4].

RESULTS

The present investigation is an attempt to create genetic variability for crop improvement by induced mutagenesis

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through physical and chemical mutagenesis in CO-4 varieties of Bengal gram (chickpea). The effect of mutagens on the economic character like, days to first flowering, days to 50% flowering, plant height at maturity, number of primary branches per plant, number of secondary branches per plant, number of pods per plants, number of seeds per pod, seed yield per plant, hundred seed weight and protein percentage were recorded.

Days to first flowering and the days to 50% flowering shows different effect with different doses/concentrations of gamma rays and EMS. The first flowering was seen at 35th day on control plants and days to 50% flowering in control were within 45 to 51 days (Table 1). In higher dose/concentration of both EMS and gamma rays, there is delay of one to set flower.

The number of primary branches ranged between 1 and 8. The highest numbers of primary branches were observed in the control. But the control plant had lower number of secondary branches per plant as compared to the segregating population. Among the treated population, a gradual reduction in mean performance was noted in number of primary branches per plant for all the mutagenic dose/concentrations. The numbers of secondary branches were increased with increasing dose/concentration of mutagen. Though the numbers of secondary branches may high, but the numbers of fertile branches were very less as compared to the control (Table 1).

The plant height was observed to be higher in the control (38.52 cm) as compared to the treated population. In gamma treated population, the height was observed in 20kR (38.28cm) and lowest was observed in 60kR (23.06cm). In EMS, the plant height was observed to be 38.10 to 4.56cm. And both treatments showed a decreasing tendency while increasing the doses/concentrations (Table 1). In EMS, at highest concentrations, the plant showed stunted growth and retardancy in some plants.

The effect of all the mutagenic treatments on number of pods per plant revealed statistically significant negative shifts in mean values. The maximum mean on number of pods was observed in control (38.73). The range of number of seeds per pods in 10mM, 20mM; 40kR, 50kR; 30mM, 40mM; had no significant difference (Table 2). With an overview of this result, it can be said that the mean value of number of seeds per pods decreased with increase in doses/concentrations of treated plants and a low percentage of empty pods were also observed in higher doses/concentrations of mutagen.

The highest percentage of hundred seed weight was obtained in control (30.04%) and lowest was in 50kR of Gamma rays. 10 and 20mM of EMS treated plants showed statistically similar results though the values were different. It is evident from the pertinent observation that statistically significant decrease in mean value for 100- seed weight was observed (Table 2). Data on mean value for protein content of the seeds in M_1 generation shows a gradual decrease with increasing concentrations. The highest percentage of protein was observed in the control (21.64).

In the present study, the quantitative traits, were analyzed to assess the extent of induced variability in M_1 generation of

chickpea. As might be expected, the variation in M_1 generation in treatments was higher when compared to control in all the studied parameters in both negative and positive directions. In M_1 generation, most of the quantitative traits showed reduction but number of secondary branches per plant, days to first flowering and days to 50% flowering were gradually increased while increasing dose/concentration of mutagens. The maximum reductions of quantitative characters were noted at 60kR of gamma rays and 50mM of EMS. The reductions in quantitative characters in M_1 generation were also reported by Banu *et al.* [12] in cowpea, Naik and Moorthy [13] in green gram and Thilagavathi and Mullainathan [14] in black gram.

As might be expected, the variation of the treated population was comparatively higher than that of the control for all the traits studied. The plant height reduction with increasing dose/concentration of mutagens was also reported by many workers such as Stamo *et al.* [15] in *Triticum* and Choudhary *et al.* [16] in *Trigonella*. Kumar and Tripathi [17] are also of the opinion that the reduction can be due to chromosomal abnormalities with mutagenic chemical. The number of primary branches per plant resulted in a negative aspect in mean value in all the physical and chemical treatments in Black gram [18].

As the dose increase, the days to first flowering increased in both treatments at higher dose/concentration of mutagens, showing a significant variation towards negative direction in days to first flowering. Mahala *et al.* [19] observed that mutagenesis could induce a wide variability to both positive and negative direction, which resulted in adequate variability in the treated population, and helps in the selection of early or late-flowering plants. The number of pods per plants showed a successive reduction with an increase in dose/concentration of mutagens. Similar reduction was observed by Khan *et al.* (2005) in chickpea and Giri *et al.* [20] in pigeon pea.

Breeders want to improve the yield together with other characters. A plant can be improved in productivity and adaptation to environment only when more genetic variabilities for the specific traits are available in the treated population. The mean yield per plant was decreased in M_1 generation on both gamma rays and EMS treatments. The decreasing trend in yield parameters has also been reported by various workers such as Khan *et al.* [21] in *Vicia faba*, Karthika and Lakshmi [22] in soybean, Khursheed *et al.* [23] in Sunflower. Reduction in yield per plant might have occurred due to disturbances in meiosis, which affected the frequency of normal microspores and megaspores and hence the trait was directly affected. The hundred seed weight is an important trait for measuring yielding ability in pulses. In this study, the hundred seed weight showed comparatively very least significant decrease from the control with most of the treatment of gamma rays and EMS. Reduction in the mean 100 seed weight has earlier been reported by Tickoo and Chandra [24] and Waghmare and Mehra [25].

The variability of quantitative characters influencing yield was much greater in mutagenic progenies than in the control in a negative direction [26]. Mutagen can cause physiological damages mainly manifested as growth retardation and death

Table 1: Mean value of days to first flowering, days to 50% flowering, number of primary branches, number of secondary branches and plant height at maturity

Mutagen	Doses/ concentrations	Days to first flowering	Days to 50% flowering	Number of primary branches	Number of Secondary branches	Plant height at maturity (cm)
Control	-	36.13±0.38	46.93±1.30	3.53±0.51	3.00±0.61	38.52±1.97
Gamma rays	20kR	38.33±0.48	50.40±0.74	3.36±0.54	2.40±0.81	38.28±1.42
	30kR	39.86±0.22	50.46±0.82	3.24±0.54	2.80±0.76	33.82±1.87
	40kR	39.93±0.64	50.57±0.88	3.16±0.71	3.93±0.93	33.69±1.87
	50kR	40.56±0.47	51.63±1.06	3.06±0.76	4.46±0.76	28.66±2.94
	60kR	40.66±0.44	52.93±1.04	2.06±0.32	3.86±0.79	27.05±0.92
EMS	10mM	39.26±0.31	48.53±0.47	3.06±0.49	4.60±0.60	38.10±1.50
	20mM	40.60±0.60	49.80±0.63	2.86±0.53	3.46±0.64	35.46±1.62
	30mM	40.60±0.61	50.80±0.97	2.66±0.50	3.65±0.80	34.12±1.80
	40mM	41.93±0.49	51.66±0.97	2.46±0.61	5.40±1.03	28.68±2.70
	50mM	43.33±0.64	53.26±0.96	2.13±0.34	6.06±0.92	24.56±1.87

Table 2: Mean value of number of pods per plants, number of seeds per plants, yield per plants, hundred seed weight and protein percentage

Mutagen	Doses/ concentrations	No. of pods per plants	No. of seeds per pods	Yield per plant (g)	100 seed weight (g)	Protein percentage(%)
Control	-	38.73±1.87	1.80±0.23	12.17±1.34	30.04±1.30	21.64±0.09
Gamma rays	20kR	37.60±2.19	1.79±0.19	11.09±1.49	29.45±0.38	21.28±0.17
	30kR	35.66±1.51	1.73±0.27	10.53±0.73	29.10±1.14	21.24±0.22
	40kR	34.60±1.68	1.60±0.25	10.44±0.80	28.33±1.30	21.23±0.34
	50kR	28.66±1.54	1.58±0.28	8.13±0.67	27.30±0.98	21.21±0.19
	60kR	22.33±2.03	1.53±0.27	6.88±0.85	26.84±0.69	20.81±0.27
EMS	10mM	35.50±2.25	1.62±0.21	9.65±1.16	29.67±1.30	21.29±0.19
	20mM	32.80±2.74	1.46±0.14	8.94±1.80	28.99±1.30	21.11±0.18
	30mM	30.40±3.41	1.33±0.27	8.33±1.31	27.80±1.30	21.03±0.20
	40mM	20.40±1.93	1.23±0.27	7.90±1.57	26.64±0.73	20.98±0.29
	50mM	22.20±3.00	1.20±0.19	6.60±0.95	24.13±1.30	20.67±0.30

is generally not restricted in M₁ generation [26]. This is an agreement with the present investigation which showed inhibitory growth and yield performance in M₁ generation with the effect of physical and chemical mutagens in chickpea. From the present study, it can be concluded that there is a scope for further improvement of this variety of mutagen with regard to the quantitative characters in the further generations.

In this research, the results showed that the differences between mutagen treatments significantly had effect on all the studied quantitative characters. Mutagenic treatments induced polygenic variability which may have further scope in chickpea improvement through its incorporation in conventional breeding.

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